Employment E¤ects of Progressive Taxation in a Unionised Economy¤

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Abstract

One of the main arguments against a public …nance solution to unemployment is that, at least in the long run, the tax burden is passed onto labour. This paper presents a general equilibrium model on the relation among tax progressivity, wage setting and employment where changes in labour taxation a¤ect the labour market equilibrium. It is shown that the relation of interest depends on the initial level of taxation and on the labour tax parameter allowed to vary (marginal-average, personal income-payroll taxes). On the basis of a calibration exercise for Italy and the US, the qualitative analysis of the model is supported and the e¤ects are quanti…ed. In particular, larger employment e¤ects are determined by a reduction in both the average (personal incomenpayroll) tax rates. Taking as a benchmark for our policy experiment the actual …scal reform during the period 1978-97, variations in the employment rate implied by our model are quite close to those empirically observed.

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1 Introduction

The e¤ect of labour taxation on unemployment di¤erentials across countries was one of the issues largely discussed in the mid-eighties following the Bean, Layard and Nickell (1986) e¤ort to organise a multicountry study. According to them, labour taxation is only partially responsible for the unsatisfactory employment performance of European countries. Their empirical evidence shows a negative but weak relationship between labour taxation and employment. This seems to con…rm the labour economists' common view that the tax burden is fully passed onto real wages.

After almost two decades, Daveri and Tabellini (2000, DT henceforth), have put such a view into question. Inspired by some data correlations, DT suggest that the combined e¤ect of monopolistic and decentralised trade unions and high labour taxation can provide an explanation for the high unemployment and slow growth of European continental countries relative to the US and UK. In other words, labour taxation a¤ects unemployment only in those countries where the labour market is unionised. In interpreting their empirical results, DT primarily refer to a model of the economy characterised by proportional labour taxation and exogenous labour supply.

Malcomson and Sartor (1987) developed the relationship between wage determination and tax progressivity which shows that, within imperfect labour markets, if labour taxation is progressive, following an increase in the sole marginal tax rate, unions reduce pre-tax wages on the basis of a "union substitution e¤ect". This substitution e¤ect weighs the increasing wage pressure in terms of the cost of foregone employment. Under the assumption of a progressive taxation system, the post-tax wages elasticity with respect to pre-tax wages is smaller than one. This implies that following an increase in the marginal tax rate holding constant the average, the marginal bene…t of increasing the wage is reduced whereas the marginal cost is invariant. Lockwood and Manning (1993, LM) further discuss the implications of a progressive taxation system on unions' wage-setting behaviour. This literature presents static, partial equilibrium models and assumes that labour supply is exogenous. Therefore, given wage determination, it derives employment e¤ects as residual from the labour demand.

More recently, a number of papers have considered the implications of tax progressivity on wage setting and employment when labour supply is endogenous. Holmlund and Kolm (1995), Calmfors (1995), Fuest and Huber (2000) and Hansen, Pedersen and Sløk (1999) show that, with an endogenous labour supply, a sole increase in the marginal tax rate has also a "labour supply income e¤ect" that may result in increasing wage pressure given the lower incentive to supply labour services. In particular, Aronsson, Löfgren

and Sjögren (1999), by developing a dynamic general equilibrium model with in…nitely lived agents, show that an increase in the sole marginal tax rate leads to a higher real wage and to a lower employment rate.

This present paper considers a general equilibrium, overlapping generations (OLG) model in which labour supply is endogenous and the labour market is not competitive. This paper aims at analysing the e¤ects of progressive labour taxation on wage determination and employment by focusing on the role played by each of the four relevant tax parameters of a progressive taxation system (namely, marginal and average rates related to personal income and payroll taxation systems). Determining the role played by each of the four labour tax parameters is an important issue as long as actual …scal reforms involve contemporaneous changes in marginal and average tax rates. For example, as shown by Wagsta¤ et al (1999) in several OECD countries, …scal reforms on personal income taxes have often led to fewer brackets (e.g. lower marginal rates) and lower average rates.

Moreover, it is largely recognised that payroll taxes may a¤ect employment (see for example Kolm (1999), to name but one). According to LM, agents' optimising behaviour implies that marginal and average personal income tax rates in‡uence employment in the same manner as marginal and average payroll taxes. This paper will show that if labour supply is endogenous this is not necessarily true. Indeed, labour supply is independent of payroll taxes, whereas it is not of personal income taxes.

Although some of these questions have already been analysed, the answers provided by the current literature are quite controversial. By providing both qualitative and quantitative analyses, this paper assesses the robustness of existing propositions in an OLG general equilibrium framework that has not been previously used to address the tax progressivity issue. Furthermore, moving from a partial to a general equilibrium framework, this paper will point to the importance of the "interest rate e¤ect" and its strict dependency on the OLG structure of the model. Following a tax shock, intertemporal decisions of individuals change as well as their opportunity cost, the real interest rate. As long as the real interest rate changes, …rms modify their decisions on the input choices. This kind of transmission mechanism can also be found in a Ramsey type model. However, in contrast to a Ramsey model where the net of tax real interest rate is determined by the households' preferences, within an OLG framework the Euler equation states that the real interest rate is a function of the ratio between old and young consumption as well as the discount factor.[1] The importance of the supply of capital as a

[1] Given the speci…c assumption of a CRRA utility function, the ratio between old and young consumption enters non linearly in the Euler equation.

leading mechanism is therefore straightforward.

Thereby, this paper will focus on the interactions among three main transmission mechanisms: a "union substitution e¤ect," a "labour supply income e¤ect" and an "interest rate e¤ect". This paper extends the DT paper by introducing a progressive taxation system and it extends all the previous static partial equilibrium analyses such as LM. Furthermore, this paper extends both by endogenising labour supply. It also generalises Aronsson et al. (1999), by considering the employment e¤ects of all labour tax shocks and by quanti…ying these e¤ects.[2] Finally, the current paper will show that the policy used for changing tax progressivity matters for the …nal e¤ects on equilibrium wages and employment.

Since the qualitative analysis of the model seems to suggest that wage and employment e¤ects of progressive taxation are likely to be ambiguous, we ran some policy experiments for two countries, Italy and the USA, in order to determine their direction and quantify their size. Italy was chosen since it is characterised by the presence of strong unions and a high unemployment rate, and it is meant to represent a typical European Continental country. The USA, given their low-unemployment experience and their tradition of weaker unions represent the Anglo-Saxon group.[3]

The rest of the paper is organised as follows. Section 2 presents the basic model. Section 3 describes the equilibrium solution. Section 4 illustrates the qualitative e¤ects of progressive taxation on wage setting and employment. Section 5 reports the calibration and section 6 the policy experiments. Finally some conclusions follow.

2 The Economy

Consider a closed economy characterised by two periods overlapping generations and composed of four main economic agents: households, unions, …rms and the government. Population is constant, there is no altruism, individuals earn only wage income when young and capital income when old. At the end of the …rst period individuals retire.

[2] As Aronsson et al. (1999) point out, their results are consistent only with an increase in the marginal tax rate holding the average tax rate constant.

[3] The Anglo-Saxon countries and in particular the USA are largely recognised as countries where labour market is almost competitive. However, empirical evidence of the presence of non-competitive forces can be found in papers such as Brunello and Wadhwani (1989) and Holmlund and Zetterberg (1991) where the estimates of the insider weight is quite high for US (0.3).

2.1 Household

Economic agents have homothetic preferences described by an intertemporal Constant Relative Risk Aversion utility function, separable over consumption and hours of work when the individual is young and employed and over consumption only when old.[4] Hence, it takes the following form:

$$U^i = \frac{1}{1-\mu}\left(c_{y;i}^{1-\mu} + g_{y;i}^{1-\mu}\right) - \varphi\frac{h_y^{\circ}}{\circ} + \frac{\beta}{1-\mu}\left(c_{o;i}^{1-\mu} + g_{o;i}^{1-\mu}\right) \qquad (2.1.1)$$

where $i = e$ (employed); u (unemployed)"; "y" and "o" stands for young and old respectively; the second term takes the value of zero if the individual is unemployed; β is a discount factor which is as usual less than j1jand that can be positive or negative according to the weight on the two periods given by the household; c_y denotes household consumption when young and c_o when old; g_y and g_o represent government consumption in the two generations; $\mu > 0$ and $\varphi > 0$ measure respectively the households' attitude to substitute consumption between the two periods and the individual's evaluation of leisure; …nally $\frac{1}{\circ}$ ($\circ > 1$) is the elasticity of marginal disutility of hours worked. Further, it is assumed that $g_y^e = g_y^u = g_o^e = g_o^u$: Households face the following budget constraints when young and old respectively:

$$!_y^i = c_y^i + s_y^i \qquad (2.1.2)$$

$$(1+r)s_y^i = c_o^i \qquad (2.1.3)$$

where

$$!^i = \begin{cases} wh - T(wh;z) & \text{if employed} \\ b & \text{if unemployed} \end{cases}$$

and $wh - T(wh;z)$ is the income of workers net of taxes; b denotes unemployment subsidies, r is the rate of return on capital, and …nally s^i indicates the individual savings. Following LM, $T(wh;z)$ labels the personal labour income taxes, z is a vector of parameters (marginal tax rates, tax band...) which takes into account any non-linearities within the tax system. Unemployment subsidies are determined by some political-economy mechanism

[4] This speci…cation generalises the cases of a log-linear utility function where μ is equal to 1 (e.g. Holmlund and Kolm (1995)) and a linear utility function where μ is equal to 0 (e.g. Sørensen (1997b)). Further, it examines the relationship between the intertemporal elasticity of substitution and changes in labour taxation.

outside the model and are not taxable by assumption.[5] Combining (2.1.2) and (2.1.3), through a standard utility maximisation procedure, it is possible to derive the general solutions for employed and unemployed hours worked, consumption and savings:

$$h^i = \begin{cases} \left[\frac{\circ}{\tau}\right]^{\frac{1}{\circ+\mu-1}} [w(1-\zeta)]^{\frac{1-\mu}{\mu+\circ-1}} [1+\iota(r)]^{\frac{\mu}{\circ+\mu-1}} & \text{if employed} \\ 0 & \text{if unemployed} \end{cases} \tag{2.1.4}$$

$$c_y^i = \frac{w^i}{1+\iota(r)} \tag{2.1.5}$$

$$c_o^i = \frac{w^i}{1+\iota(r)} [\Gamma(1+r)]^{\frac{1}{\mu}} \tag{2.1.6}$$

$$s^i = \frac{\iota(r)}{1+\iota(r)} w^i \tag{2.1.7}$$

where $\iota(r) = \Gamma^{-\frac{1}{\mu}}(1+r)^{\frac{1-\mu}{\mu}}$. We introduce the parameter $\circ$; suggested by Musgrave and Musgrave (1976), which measures the personal income tax progressivity and corresponds to the value of $(1-\zeta)/(1-t)$, given that ζ and t represent respectively the marginal and the average personal income tax rates. It should be noted that $\circ$ is inversely related to tax progressivity.[6] Finally, given the budget constraint and under the assumption of full capital depreciation, savings of the young at time t set the capital stock at time $t+1$ that, combined with the labour supplied by the next young generation, produces output at time $t+1$.[7] Hence, savings depend on the income net of taxes, the return on savings, the discount factor and the elasticity of substitution between consumption.[8]

[5] If unemployment bene…ts are assumed taxable, then changes in the parameter z of the taxation system would a¤ect the marginal and average rate of the bene…ts' brackets. Then, in evaluating the e¤ect of changes in taxation on wages one should also consider this e¤ect. However, since bene…ts are conceived as unemployment bene…ts only and since individuals can not earn other income rather than wages, it is quite likely that unemployment bene…ts would be below the threshold and therefore untaxed.

[6] The parameter $\circ$ is well-known in the literature as the coe¢cient of residual income progression and it corresponds to the elasticity of the after-tax wage with respect to an increase in the pre-tax wage.

[7] Full capital depreciation is not a strong assumption given that our model considers just two periods.

[8] This is strictly related to the functional form assumption of the utility function.

2.2 Firms

There exists a measure one identical competitive …rms indexed by j. Their technology is described by a Cobb-Douglas production function formalised as follows:

$$y_j = Ak_j^{®} l_j^{1 \, i \, ®} \tag{2.2.1}$$

Let's de…ne l, the labour input, as the number of workers times the hours of work.[9] Since the goods market is competitive, the …rms' optimisation problem consists of maximising the following pro…t function:

$$\max_{l_j;k_j} ¼_j = y_j \; ¡ \; l_j(w_j + D(w_j; z^{0})) \; ¡ \; rk_j \tag{2.2.2}$$

where $D(w_j; z^{0})$ represents the payroll taxes and z^{0} is a vector of parameters of the payroll tax system. Labour demand can thus be obtained by inverting the …rst order conditions with respect to labour:

$$l_j(w_j) = \left[\frac{(1 \; ¡ \; ®) Ak_j^{®}}{w_j + D_j(w_j; z^{0})} \right]^{\frac{1}{®}} \tag{2.2.3}$$

Finally, since capital markets are competitive, for the …rst order condition with respect to capital, the equilibrium rate of return on capital is equal to the marginal productivity of capital:

$$r = ®A \left(\frac{K}{L} \right)^{®-1} \tag{2.2.4}$$

2.3 Government

The aim of the government is to keep the following budget constraint balanced:

$$twhN + dwhN = (1 \; ¡ \; N)b + G \tag{2.3.1}$$

where d stands for average payroll tax rate and G represents government consumption. The balanced budget constraint (2.3.1) is guaranteed by the condition that changes in public consumption counterbalance the changes of tax rates.[10]

[9] That is, workers and hours of work are perfect substitutes in production.

[10] To simplify the exposition, indirect taxation (e.g. VAT), is not taken into account

2.4 Unions

The labour market is characterised by the presence of monopolistic unions at …rm level which set wages. Since output prices are normalised to unity, setting nominal (pre-tax) wages is equivalent to setting real wages. Unions are unable to a¤ect …scal policy decisions and their aim is to maximise the expected utility of members subject to the labour demand (2.2.3) and household hours supply function (2.1.4). Note that an interior solution to the maximisation problem is guaranteed by the presence of some unemployed among union members. The unions' optimisation problem takes the form:

$$\max_{w_j} N_j(w_j)\left[U^e - U^u\right] = \max_{w_j} \frac{l_j(w_j)}{h(w_j)}\left[U^e - U^u\right] \tag{2.4.1}$$

Following LM, it is possible to obtain an explicit solution for (2.4.1):

$$(wh(1-t))_j = bM \tag{2.4.2}$$

The post-tax real wage $(wh(1-t))$ is an increasing function of the unemployment bene…t (b) and union markup (M). Two things are worth noting. First, given that $\frac{(wh(1-t))_j}{b} = M$ and since union markup is higher than 1, the post-tax real wage is higher than the unemployment bene…ts and changes in union markup imply changes in the ratio between the post-tax wage and the altenative wage.[11] Further, union markup is increasing in τ. That is, a higher marginal tax rate, keeping the average tax rate constant, reduces the marginal bene…t of increasing the pre-tax wage, whereas the marginal cost is invariant. This raises the cost in terms of foregone employment of an increase in the post-tax wage and produces the well known substitution e¤ect which reduces wage pressure. Secondly, union markup with respect to payoll taxes is equal to:[12]

$$\left(1 - \frac{\tau_h}{\mu(1+\tau_h)}\right)\left(\frac{\tau}{\tau}\right)^{\frac{1}{1-\mu}} \tag{2.4.3}$$

for two main reasons. Firstly, each …rm produces an identical good and prices are taken as given. Secondly, they are proportional and therefore their coe¢cient of progression is equal to 1. This implies that their changes do not a¤ect unions' markup. Further, it is assumed that capital income is not taxable.

[11] Unemployment bene…ts can be conceived as equal to the competitive wage.

[12] Union markup with respect to personal income taxes is slightly di¤erent since some other parameters that enter into the hours supply function should be included.

where $\hat{A}(\mu; \bar{\ }; r)$ is de…ned as $\frac{1 - \mu}{(1+\gamma)^{1-\mu}}(1 + \tau(r))^{1-2\mu}$; ε_h labels the constant $\frac{1-\mu}{\mu+\theta-1}$ elasticity of hours of work with respect to a wage rate, $\gamma(r) = -\frac{1+\mu}{\mu}(1+r)^{\frac{1}{\mu}}$ and $\theta\varphi$ corresponds to the product of θ and φ: The latter parameter, δ; measures the payroll tax progressivity and corresponds to the ratio $[(1 + d) = (1 + \pm)]$ where d and $\pm$ denotes the average and marginal payroll tax rate respectively. De…ning the labour cost as $LC = w + D(w)$, δ corresponds to the inverse of the elasticity of labour cost. Though unions care about post-tax wages, they set pre-tax wages. Rearranging equation (2.4.2), one obtains the implicit form solution for w_j:

$$w_j = \frac{b}{h(1 - t)}M \tag{2.4.4}$$

According to equation (2.4.4), pre-tax wage is an increasing function of unemployment bene…ts and union markup but it is decreasing in hours of work. That is, labour supply endogenisation introduces an income e¤ect according to which it is no longer possible to identify a "pure" substitution e¤ect on wage determination. In symmetric equilibrium, the …rm speci…c wage and labour demand are equal to the aggregate ones. Henceforth, the subscript "j" is then omitted.

3 The Equilibrium

The equilibrium condition in the goods market is given by:

$$K_{t+1} = S_t \tag{3.1.1}$$

where K_{t+1} indicates the economy's capital stock at time t + 1 and S_t denotes the savings of the economy. Equation (3.1.1) states that investments are equal to net savings given the hypothesis of full capital depreciation. The expression for savings is then the following:

$$S = ns^e + (1 - n)s^u = \frac{\tau(r)}{1 + \tau(r)}wh(1 - t)(n + (1 - n)\varphi) \tag{3.1.2}$$

where n represents the proportion of young employed within the labour force and φ denotes the replacement ratio which is assumed to be a function

of per capita real net wage $\varphi = \frac{b}{wh(1-t)}$. Substituting (3.1.2) into (3.1.1) one obtains:

$$K_{t+1} = \frac{\theta(r)}{1+\theta(r)} wh(1-t)[n + (1-n)\varphi] \qquad (3.1.3)$$

The stock of capital at time t+1 depends on the marginal propensity to save, the post-tax wage and the employment rate. Within the labour market, the equilibrium level of employment N* can be derived combining the aggregate wage equation (2.4.4) and the aggregate labour demand determined by the …rms (2.2.3):[13]

$$N_t^{\alpha} = \frac{(1-\beta) rs^u}{\beta(1+d) wh - (1-\beta) r (s^e - s^u)} \qquad (3.1.4)$$

All these results allow standard interpretations. Thereby, the economy's equilibrium is determined by all the following conditions:

1) The individual quantities $(c_{it}; k_{it}; h_t)$ are derived from the representative agent optimisation problem given $(r_t; w_t; b_t)$;

2) The real interest rate r_t is equal to the marginal product of capital from the …rm's optimisation problem;

3) The wage at …rm level (w_{jt}) is set by the decentralised trade unions' optimisation problem given $(r_t; n_t; c_t; b_t; h_t)$;

4) Employment at …rm level n_{jt} is set by the representative …rm given $(r_t; w_t; b_t)$;

5) The goods market and the capital market clear;

6) The government budget constraint is satis…ed;

7) The consistency condition guarantees that $c_{it} = c_t$; $k_{it} = k_t$, $h_{it} = h_t$ and $w_{jt} = w_t$

4 The qualitative analysis.

The purpose of this section is to analyse the e¤ect of changes in each of the four labour tax parameters of interest on wage setting and employment.[14]

[13] To be more precise, note that this refers to the aggregate version of equations (2.4.4) and (2.2.3).

[14] Henceforth, except when explicitly stated, each rise in tax rates is allowed keeping constant all the others tax parameters.

4.1 Tax progressivity and wage determination.

Proposition 1 The e¤ect on wage determination of a rise in marginal personal income tax rate depends on a "union substitution e¤ect" and on a "labour supply income e¤ect." A higher average personal income tax rate determines an increase in wages.

Proof.

$$\frac{dw}{d¿} = \frac{@w}{@h}\frac{@h}{@v}\frac{@º}{@¿} + \frac{@w}{@M}\frac{@M}{@º}\frac{@º}{@¿} \gtrless 0 \qquad (4.1.1)$$

where $\frac{@w}{@h} < 0; \frac{@h}{@v} > 0; \frac{@º}{@¿} < 0; \frac{@w}{@M} > 0; \frac{@M}{@º} > 0; \frac{@º}{@¿} < 0$

$$\frac{dw}{dt} = \frac{@w}{@h}\frac{@h}{@t} + \frac{@w}{@M}\frac{@M}{@º}\frac{@º}{@t} + \frac{@w}{@t} > 0 \qquad (4.1.2)$$

where: $\frac{@w}{@h} < 0; \frac{@h}{@t} > 0; \frac{@w}{@M} > 0; \frac{@M}{@º} > 0; \frac{@º}{@t} > 0$;and $\frac{@w}{@t} > 0$

Expressing all these variations in terms of elasticity (absolute values), we obtain:

$´_{h;t} = \frac{¹}{¹ + ¡ 1}\frac{t}{1 ¡ t}$ and $´_{w;t} = \frac{t}{1 ¡ t}$ where $\frac{¹}{¹ + ¡ 1} < 1$: ■

Equation (4.1.1) shows that labour supply introduces an income e¤ect $\left(\frac{@w}{@h}\frac{@h}{@v}\frac{@º}{@¿} > 0\right)$ that contrasts the "union substitution e¤ect" $\left(\frac{@w}{@M}\frac{@M}{@º}\frac{@º}{@¿} < 0\right)$ on wage determination. Then, the sign of the above total di¤erential is ambiguous and depends on the larger of the two e¤ects. This result can not be conceived as properly novel since the implications of an endogenous labour supply have already been a matter of concern of other papers. (cfr. Fuest and Huber (2000) and Hansen et al (1999)). Note that since some union members are unemployed, unambiguously we still obtain a "union substitution e¤ect" despite of the presence in the union markup of some labour supply parameters.[15]

According to equation (4.1.2), since $\frac{¹}{¹ + ¡ 1}$ is less than one, unions' attempt to protect wages from the taxation increase dominates the opposite e¤ect due to changes in hours worked. Nevertheless, this counterbalancing labour supply e¤ect appears to be a good reason to cast some doubts on LM's result of a more than 100% wage shift.[16] This means, that the burden

[15] Unions' behaviour in the wage process is independent of how they weigh employment. However, if some members are unemployed, they have even more incentive to substitute lower wage for employment. Note that, a higher proportion of unemployed, implies a higher equilibrium wage over the competitive wage, then a higher union markup, a lower income e¤ect, since wage is higher, or, the other way round, a higher substitution e¤ect.

[16] The more than 100% shift is due to the combined e¤ect of a complete pre-tax wage recovery from the increase in taxation and a further increase triggered by the union markup variation.

of labour taxation is not shifted completely onto …rms even though unions have monopolistic power. The amount of tax burden transferred to …rms depends on the initial taxation level $\left[\frac{t}{1-t}\right]$ and on the worked hours elasticity with respect to the average tax rate $\frac{\mu}{\mu+\gamma-1}$. Hence, following a rise in the average personal income tax rate, the monopolistic union increases the wage pressure as suggested by DT but the strength of this claim does not depend on unions' power but on the initial taxation level. If the taxation level is extremely high, a further increase in the tax rate implies an heavy cost for the workers, thus the compensating rise in the wage would be higher than what required for a lower initial taxation level.

Proposition 2 An increase in the marginal (average) payroll tax rate lowers (increases) the real wage if and only if $\mu < 1$:

Proof. $\mu < 1$

$$\frac{dw}{d\tau} = \frac{\partial w}{\partial M}\frac{\partial M}{\partial \gamma}\frac{\partial \gamma}{\partial \tau} < 0 \qquad (4.1.3)$$

$$\frac{dw}{d\delta} = \frac{\partial w}{\partial M}\frac{\partial M}{\partial \gamma}\frac{\partial \gamma}{\partial \delta} > 0 \qquad (4.1.4)$$

where: $\frac{\partial w}{\partial M} > 0; \frac{\partial M}{\partial \gamma} > 0; \frac{\partial \gamma}{\partial \tau} < 0; \frac{\partial \gamma}{\partial \delta} > 0$
$\mu > 1$

$$\frac{dw}{d\tau} = \frac{\partial w}{\partial M}\frac{\partial M}{\partial \gamma}\frac{\partial \gamma}{\partial \tau} > 0 \qquad (4.1.5)$$

$$\frac{dw}{d\delta} = \frac{\partial w}{\partial M}\frac{\partial M}{\partial \gamma}\frac{\partial \gamma}{\partial \delta} < 0 \qquad (4.1.6)$$

where: $\frac{\partial w}{\partial M} > 0; \frac{\partial M}{\partial \gamma} < 0; \frac{\partial \gamma}{\partial \tau} < 0; \frac{\partial \gamma}{\partial \delta} > 0$ ■

According to all the above equations, payroll taxes could a¤ect wage setting di¤erently from personal income taxes. This result contrasts what suggested by LM. First, payroll taxes do not have any direct e¤ect on labour supply and wage variations depend only on union markup changes.[17] Secondly, how individuals discount future consumption is quite relevant. Unions

[17] This result is exactly that shown by LM.

weigh the cost of foregone employment on the basis of the intertemporal elasticity of substitution between consumption.[18]

Consider for example the case $\mu > 1$: Under this assumption, following an increase in the marginal payroll tax rate, unions raise their wage claim (cfr (4.1.5)). Since the average rate is held constant, the labour demand is unaffected.[19] Thus, the marginal cost is invariant whereas the marginal bene…t of changing the wage is positive because individuals have strong preferences for consuming today rather than tomorrow.

Assuming an increase in the average rate, keeping constant the marginal rate, implies a real wage reduction because the marginal cost of a rise in the wage is higher than the marginal bene…t (cfr (4.1.6)). Hence, if unions ask for a higher wage, a relatively small fraction of union members would be better o¤ since their preferences of consuming more today would be satis…ed but many others would become unemployed.

4.2 Tax progressivity and employment

Proposition 3 Employment e¤ects of changes in personal income taxes depend on an "interest rate e¤ect" and a "union substitution e¤ect." An increase in the marginal personal income tax rate implies higher employment if and only if the "union substitution e¤ect"dominates the "income labour supply e¤ect" on wage determination. An increase in the average personal income tax rate implies lower employment.

Proof.

$$\frac{dn}{d\tau} = \frac{\partial r}{\partial o}\frac{\partial o}{\partial \tau} + \frac{\partial n}{\partial M}\frac{\partial M}{\partial o}\frac{\partial o}{\partial \tau} \gtrless 0 \tag{4.2.1}$$

where: $\frac{\partial r}{\partial o} \gtrless 0 \;\Rightarrow\; \begin{cases} \frac{\partial r}{\partial o} < 0 & \text{if } \frac{dw}{do} > 0 \\ \frac{\partial r}{\partial o} > 0 & \text{if } \frac{dw}{do} < 0 \end{cases}$, $\frac{\partial n}{\partial M} < 0$; $\frac{\partial M}{\partial o} > 0$; $\frac{\partial o}{\partial \tau} < 0$

$$\frac{dn}{dt} = \frac{\partial r}{\partial o}\frac{\partial o}{\partial t} + \frac{\partial n}{\partial M}\frac{\partial M}{\partial o}\frac{\partial o}{\partial t} + \frac{\partial n}{\partial t} < 0 \tag{4.2.2}$$

where: $\frac{\partial r}{\partial o} < 0$ given that $\frac{dw}{dt} > 0$; $\frac{\partial o}{\partial t} > 0$; and $\frac{\partial n}{\partial t} < 0$ ■

[18] Note further that the sign of the elasticity of hours worked with respect to a wage rate $\frac{1-\mu}{\mu+1}$ depends on the value taken by the intertemporal elasticity of substitution between consumption ($\mu \gtrless 1$): If $\mu = 1$ (log-linear utility function), this elasticity is equal to zero.

[19] Note that the average payroll tax rate enters into the labour demand and thus it is often conceived as a sort of hiring cost.

All three transmission channels of our interest can be identi…ed in equation (4.2.1). Consider …rst, that related to changes in the real interest rate $\left(\frac{\partial r}{\partial \sigma}\frac{\partial \sigma}{\partial \iota}\right)$. It is clear that this latter e¤ect, due to the general equilibrium framework, is novel to all the partial equilibrium literature. Being the user cost of capital, at a given wage, the real interest rate in‡uences the …rms' decisions on the input choices. Furthermore, the real interest rate in‡uences the labour market also through the hours supply of work since it changes the opportunity cost of working today. The sign of $\frac{\partial r}{\partial \sigma}$ depends on the "labour supply income e¤ect" $\left(\frac{\partial r}{\partial \sigma} > 0\right)$ and the "union substitution e¤ect" $\left(\frac{\partial r}{\partial \sigma} < 0\right)$ on wage determination. In particular, note that a novel implication of (4.2.1) is that when the employment e¤ect is ambiguous $\left(\frac{\partial r}{\partial \sigma} > 0\right)$ this kind of change in taxation may end up in a positive correlation between changes in real wage and changes in employment.[20] We can then conceive a change in tax progressivity that increases both wages and employment. This is, for example, as can be observed in a Scandinavian country like Norway where the correlation between changes in real wages and employment for the period 1978-1997 is positive. Finally, the "union substitution e¤ect" has also a direct positive e¤ect on employment $\left(\frac{\partial n}{\partial M}\frac{\partial M}{\partial \sigma}\frac{\partial \sigma}{\partial \iota} > 0\right)$.

Under the same assumption, an increase in the average personal income tax leads unions' wage claims to rise and therefore all the trasmission mechanisms $\left(\frac{\partial r}{\partial \sigma}\frac{\partial \sigma}{\partial t} < 0\right)$; $\left(\frac{\partial n}{\partial M}\frac{\partial M}{\partial \sigma}\frac{\partial \sigma}{\partial t} < 0\right)$ and $\left(\frac{\partial n}{\partial t} < 0\right)$ work in the same direction determining lower employment. Though, because of the endogenous labour supply, the wage pressure is lower than 100% and the impact on employment could be weaker than what expected by LM or it could be stronger because of the presence of the interest rate e¤ect.

Proposition 4 An increase in the marginal (average) payroll tax rate determines a higher (lower) employment rate if $\mu < 1$.

Proof.

$$\frac{dn}{d\pm} = \frac{\partial r}{\partial \tilde{o}}\frac{\partial \delta}{\partial \pm} + \frac{\partial n}{\partial M}\frac{\partial M}{\partial \delta}\frac{\partial \delta}{\partial \pm} \gtrless 0 \tag{4.2.3}$$

$$\frac{dn}{d\delta} = \frac{\partial r}{\partial \delta}\frac{\partial \delta}{\partial d} + \frac{\partial n}{\partial M}\frac{\partial M}{\partial \delta}\frac{\partial \delta}{\partial d} + \frac{\partial n}{\partial d} \gtrless 0 \tag{4.2.4}$$

if $\mu < 1$

[20] Note that a positive correlation between changes in wages and employment can hardly be explained only in terms of the labour demand.

$\frac{\partial r}{\partial \gamma} < 0; \frac{\partial n}{\partial M} < 0; \frac{\partial M}{\partial \gamma} > 0, \frac{\partial \gamma}{\partial \pm} < 0; \frac{\partial \gamma}{\partial d} > 0, \frac{\partial n}{\partial d} < 0:$

if $\mu > 1$

$\frac{\partial r}{\partial \gamma} < 0; \frac{\partial n}{\partial M} < 0; \frac{\partial M}{\partial \gamma} < 0, \frac{\partial \gamma}{\partial \pm} < 0; \frac{\partial \gamma}{\partial d} > 0, \frac{\partial n}{\partial d} < 0:$ ■

Following a change in payroll taxes there is not a "labour income supply effect" on wage determination, and for a given μ the sign of $\frac{\partial r}{\partial \tilde{\tau}}$ is unambigous. In particular, if $\mu < 1$, the two relevant channels, namely the real interest rate effect $\frac{\partial r}{\partial \tilde{\tau}} \frac{\partial \gamma}{\partial \pm}$ and the union substitution effect $\frac{\partial n}{\partial M} \frac{\partial M}{\partial \gamma} \frac{\partial \gamma}{\partial \pm}$; work in the same direction. Thereby, an increase in the marginal (average) payroll tax rate ends up in higher (lower) employment. Changes in the average payroll tax rates differ from those related to marginal rates since the former introduce a further mechanism $\left(\frac{\partial n}{\partial d}\right)$, which reinforces the previous two. Finally, the magnitude of the employment effect depends on the initial taxation level.[21]

Table 1 summarises the basic results.

Table 1
Summary of the basic qualitative results:

	Personal Income		Payroll			
	¿	t	±		d	
			$\mu < 1$	$\mu > 1$	$\mu < 1$	$\mu > 1$
w	"#	"	#	"	"	#
n	"#	#	"	"#	#	"#

We conclude that from a qualitative point of view, only after a change in the average personal income tax rate, keeping constant all the other tax rates, we are able to identify unambiguously the sign of the effect on wages and employment.

5 The Quantitative Analysis

5.1 Calibration

The calibration procedure offers two main advantages. The first is to solve numerically the model which does not present a closed form solution for all the steady state equations. The second is to establish the direction and quantify the effects of changes in the tax parameters of our interest through the identification of all the deep parameters.

[21] This statement can easily be proved by showing that the elasticity of employment with respect to average payroll tax rate is equal to $\frac{d}{1+d}$.

The model described in the previous sections is characterised by 10 parameters ($\mu; \theta; \bar{}; b; \alpha; \delta; \tau_c; \tau_l; \tau_k; \tau_d$) of which the four tax parameters ($\tau_c; \tau_l; \tau_k; \tau_d$) are taken from independent data source and all the others are calibrated from the model's steady state equations. Before describing the calibration procedure in details, it is worth introducing the two countries over which we carried out our policy experiments: Italy and the US. The choice is made aiming at comparing a European Continental country such as Italy with an Anglo-Saxon country with a low unemployment experience like the US. Moreover, this choice allows us to focus on the role played by unions and to investigate quantitatively the DT hypothesis of strong unions able to shift the tax burden onto …rms. In fact, the two countries of interest are characterised by the presence of unions whose strength is quite di¤erent. In particular, they are both decentralised but Italian unions are traditionally stronger.

We start by setting the period equal to 20 years and by assuming that the following expressions hold within the data $Y_{kp} = (r + \delta_{kp})K_p$; $Y_{kd} = (r + \delta_{kd})K_d$; and $Y_{kg} = (r + \delta_{kg})K_g$; where r denotes the real interest rate, δ represents the capital depreciation rate which is equal to 0.025 per quarter, K_p; K_d and K_g denote respectively the sum of gross …xed capital formation and inventories stock, consumption of private and public durable goods.[22] Country speci…c real interest rate is calculated from Fisher's identity ($r \acute{} i ¡ \frac{1}{4}^e$) where the expected in‡ation is set equal to a …ve-year average of lagged in‡ation. Data are provided by the Bank of Italy and the Federal Reserve. The capital share, α; is then calibrated according to the following expression:

$$\alpha = \frac{Y_{kp} + Y_{kd} + Y_{kg}}{GNP + Y_{kd} + Y_{kg}} \tag{5.1.1}$$

On the basis of (5:1:1) we obtain that for Italy the capital share is equal to 0.36 while for US the parameter takes the value of 0.33. These two values are consistent with observed data according to which during the last decades the capital share has been higher in the European Continental countries than in the Anglo-Saxon group.

The parameter μ; the inverse of the intertemporal elasticity of substitution for consumption, is an important parameter. The value refers to that suggested by Attanasio and Jappelli (1998) on the basis of Attanasio and Weber's (1993) estimates of the intertemporal elasticity of substitution

[22] A 2.5% per quarter depreciation rate is consistent with the assumption of full capital depreciation in steady state. If one considers that it takes 20 years (the number of years for which a generation lasts) to the economy to move from one to another steady state, the above assumption implies that capital is completely depreciated after 10 years.

(0.8). Thus, μ is set equal to 1.25 for both countries. Given a value for μ, we calibrate the parameters β and δ: The former is calculated from the Euler Equation:

$$\beta = \left(\frac{c_o}{c_y}\right)^{\mu} \frac{1}{1+r} \tag{5.1.2}$$

where the ratio between old and young people's consumption is equal to 0.92 and 0.69 for Italy and US respectively.[23] The latter derives from Pencavel's estimates of worked hours elasticity with respect to a wage rate:

$$\varepsilon_h = \frac{1-\mu}{\mu+\delta-1} = -0{:}094 \tag{5.1.3}$$

It should be noted that in both cases the condition that δ might be higher than unity holds. Taking the tax parameter t from the data, the parameter b is instead calibrated from the identity:

$$b = \gamma wh(1-t) \tag{5.1.4}$$

where the replacement ratio value, γ; corresponds to the inverse of the union markup as implied by the theoretical model and the hours of work proportion over total hours is constructed from the data.[24] The average weekly hours of work in the manufacturing sector (1978-97) is divided to 96 hours (e.g. 16 hours times 6 working days). Moreover, as implied by the Cobb-Douglas production function w is equalised to:

$$w = r\frac{(1-\alpha)}{\alpha}\frac{K}{L} \tag{5.1.5}$$

where real interest rate and the ratio K=L values are taken from the data while the capital share is equal to the calibrated values, 0.36 and 0.33. Finally, given $\mu; b; \delta$ and M, the parameter φ is calibrated from the FOC for the hours of work in the utility maximisation process, that is:

[23] The value for Italy is calculated from data reported by Jappelli and Modigliani (1999). Data refers to repeated cross-sections (1984-1995) based on the Bank of Italy's Survey of Household Income and Wealth (SHIW). The ratio for the US is obtained using cross-sectional data (1987-1998) relative to Consumer Expenditure Survey (CEX) by the Bureau of Labour Statics.

[24] Eurostat and Bureau of Labour Statistics provide the data.

$$' = \circ (bM)^{1 i \mu} \frac{(1 + {}^{1})^{\mu}}{h^{\circ}} \qquad (5.1.6)$$

Table 2 summarises the calibration:

Table 2
Calibration Summary

Country	®	°	¯	µ	'	b
Italy	0.36	2.41	0.87	1.25	22.04	0.34
USA	0.33	2.41	0.61	1.25	24.07	0.32

Table 3 instead shows the tax parameters that are taken from independent data sources. The tax rates refer to those burdened onto a single income couple, earning an average wage in the manufacturing sector, with two children and onto his employer.

Table 3
Tax Parameters

Country	¿	t	±	d	o	ð	o¤
Italy	0.28	0.15	0.48	0.44	0.85	0.98	0.83
USA	0.34	0.20	0.08	0.26	0.82	1.17	0.96

Note that the personal income taxes are higher in the US where this taxation system is also more progressive. In contrast, payroll tax rates are much higher in Italy and the Italian payroll taxation system is progressive whereas the American one is regressive.[25] Illustrated by Table 4 are the two countries' steady state characteristics implied by the calibration procedure.

Table 4
Steady State Characteristics of the two countries:

Country	c_y	c_o	$\frac{c_o}{c_y}$	$\frac{c}{y}$	s	$\frac{s}{y}$	g	$\frac{g}{y}$	r	M	u
Italy	0.21	0.19	0.94	0.51	0.18	0.23	0.21	0.27	0.06	1.15	10%
USA	0.22	0.15	0.71	0.54	0.15	0.21	0.17	0.25	0.05	1.13	6%
Note: All Variables are normalised by the labour force											

[25] Further evidence that the personal income tax system is more progressive in the USA rather than Italy can be found in Wagsta¤ et al (1999). In their paper progressivity refers only to the personal income taxes and it is measured, using di¤erent data sources, by the Kakwani index.

where \u" stands for unemployment rate. Note that in order to be able to express our employment e¤ects in terms of the unemployment rate we conceive the employment rate as the ratio between employment and labour force. This can not be regarded as a strong assumption since in our model the whole population is allowed to participate. Results presented in Table 4 are quite consistent with some empirical characteristics of the two countries. For example, Italy presents a higher savings rate, a higher real interest rate, a higher union markup and a higher government expenditure ratio.

5.2 Policy Experiments

Before describing our policy experiments, it is worth looking at the actual labour tax variations in Italy and US during the period 1978-1997 to have a more precise idea on the empirical relevance of our model.

Table 5
Labour Tax and Unemployment Changes (1978 ¡ 97)

Country	%t	%¿	%d	%±	%º	%ϑ	%º¤	%u
Italy	19.3	3.99	0.15	0.16	-0.33	0.1	-0.21	7.8
USA	0.65	2.61	1.06	1.59	-1.00	0.13	-0.65	1.19

According to Table 5, personal income taxes changes have been larger in Italy than the US, though the increase in the progressivity of this taxation system is bigger in the US ($j\%º_{us}j > j\%º_{it}j$). In both countries the payroll tax systems seem to be quite unchanged. Our policy experiments will help to shed some light on the single and combined e¤ect of labour tax rate changes in the two economies. A di¤erent set of policy experiments is run for both countries. Initially, aiming at quantifying the single e¤ect of labour tax parameters on wages and employment, each of them is allowed to vary keeping constant all the others. After that, we will take as a benchmark tax changes illustrated in Table 5.[26] Note that, since these policy experiments are meant to be a comparison between di¤erent steady state equilibria, we focus only on the long-run implications of changes in taxation without considering short-run and transitional dynamics.[27;28]

[26] We also ran some experiments where the restriction of a constant overall level of tax progressivity is imposed. Under this assumption the employment e¤ects are quite neglible. This is consistent with our …ndings of di¤erent e¤ects associated to di¤erent tax parameters and the importance of changing tax progressivity. Then, for ease of exposition these results are not reported but are available upon request.

[27] This seems not to be a strong limit of the calibration with regard to the theoretical model given that there exists only two overlapping generations.

[28] Note further, it is like saying that changes in taxation are permanent.

5.2.1 Marginal Personal Income Tax Rate E¤ects

Figure A1, reported in the appendix, illustrates the implications for Italy and US of the sole change in marginal personal income tax rates.[29] For both countries changes in ¿ are always positively correlated to changes in wages. This suggests that the "labour supply income e¤ect" always dominates "the union substitution e¤ect". The size of the …nal e¤ect on wages appears to be strongly related to the initial taxation level. Indeed, the wage variation is larger in the US (-0.14% against -0.10% for Italy when we impose a 1% reduction in ¿) where the actual marginal tax rate and the personal income tax progressivity are higher.[30]

Figure A1 shows further that the interest rate e¤ect is stronger than the union substitution e¤ect leading to a negative correlation between ¿ and employment even though union markup is decreasing in ¿. As expected, the coe¢cient is bigger for the US where the initial level of taxation is higher. Note that the presence of this general equilibrium mechanism is quite important since the union substitution e¤ect alone does not appear to be strong enough to suggest this kind of …scal reform as a solution to unemployment (e.g. 0.05% for Italy and 0.07% for US following a 1% reduction in ¿). By a¤ecting intertemporal decisions of individuals, it appears that labour taxation could be harmful to capital accumulation as much as capital taxation. Table A1 provides more evidence in this regard. For both countries changes in ¿ are negatively correlated to changes in consumption, savings, real interest rate and government expenditures. Two main points are worth noting here. First, because of the increase in the employment rate, even though the marginal tax rate is lower, government expenditure is increasing since total tax revenues are rising. Secondly, identifying aggregate private output as the sum of consumption and savings, the above results seem to imply that a lower tax progressivity (¿ #) determines higher employment and output. Though the e¤ect on employment is somehow controversial to the majority of the papers within the literature, the e¤ect on output is not surprising to the most. Many argue that higher tax progressivity (¿ ") disincentives human capital accumulation. What is novel here is that it appears to disincentivate capital accumulation as well.

5.2.2 Average Personal Income Tax Rate E¤ects.

Figure A2 shows that, consistently with Proposition 1, a decrease in the average personal income tax rate triggers a wage reduction and a rise in the

[29] Henceforth all tables and …gures can be found in the appendix.

[30] See Table A1 for more details.

employment rate. More speci…cally, a 1% decrease in t yields to an increase in the employment rate equal to 0.4% and 0.6% for Italy and the US. Three things deserve to be noted. First, reducing both personal income tax rates has a positive e¤ect on employment, though it is stronger when determined by a reduction in the average tax rate.[31] Secondly, this policy experiment provides further evidence that what mostly matters for the size of the e¤ect is the initial taxation level. Thirdly, it is illuminating to understanding the role played by the real interest rate. In particular, the US case is quite interesting where, independently of decreasing or increasing the tax rate, the e¤ect on consumption, savings and private output is negative. Table A2 can shed some light on this. For both countries, the relation between the real interest rate and t is negative triggering a higher employment rate. However, since the impact on wages and hours worked is stronger in the US because of a higher initial taxation level, these latter e¤ects are strong enough to determine a fall down in consumption and savings despite of the interest rate and the employment rate are increasing. Note that this negative e¤ect on consumption, savings and private output diminishes as the reduction in t is bigger due to the increase in the employment rate. This implies that under this policy experiment, the more progressive the taxation system becomes the less the negative impact on output.[32] In contrast, in Italy the combined e¤ect of a higher interest rate and employment rate leads to a slight increase in consumption and savings. Thereby, the new steady state is associated to a somewhat higher output level.

5.2.3 Marginal Payroll Tax Rate E¤ects

As expected from Proposition 2, since $\mu > 1$; changes in marginal payroll tax rate, illustrated in Figure A3, are positively correlated to changes in union markup and wages for both countries. Provided that ± does not in‡uence worked hours, variations in wages depend entirely on changes in union markup.[33] Yet these two e¤ects are very small and almost identical and they are stronger in Italy where the initial level of taxation is higher. Furthermore, in Italy variations of the employment rate seem primarily to re‡ect changes in wages whereas in the US they do not. We can be more precise by looking at Table A3 according to which there is a strong link between

[31] Note that a decrease in t (¿) implies a higher (smaller) degree in tax progressivity.

[32] Note that in the previous policy experiment an increase in tax progressivity (e.g. a rise in the marginal personal income tax rate) leads always to a lower output level. In contrast, a higher degree of tax progressivity achieved by decreasing the average tax rate does (may) not have this negative e¤ect in Italy (in the US).

[33] Table A3 shows that changes in hours of work are very close to zero.

savings, consumption and payroll taxes.[34] While in Italy consumption and savings' changes are quite small, in the US they are large enough to determine a relatively large negative e¤ect on private output. This negative e¤ect is stronger when associated to an increase in the tax rate (e.g. when the payroll progressivity increases). Nevertheless, changes ± a¤ect positively the employment rate for a reduction of the tax rate higher than 1%. This is due to the fact that the increase in the real interest rate and the reduction in wages lead …rms to substitute capital for labour. Note however that for both countries, the gains in terms of employment are so small to suggest that pure changes in marginal payroll taxes can not represent a policy solution to unemployment.

5.2.4 Average Payroll Tax Rate E¤ects

Figure A4 describes the role played by changes in the average payroll taxes. For both countries the e¤ect of changes in wages can not help much to account for changes in the employment rate. In Italy when we allow for a reduction in d the increase in union markup is almost identical to wage changes. Both of them are much lower than the employment rate e¤ect. Average payroll taxes enter into the labour demand as a labour cost and for this reason they can be conceived as a sort of hiring cost. Then, it seems quite obvious that employment increases as long as d decreases (payroll tax progressivity increases).[35] Though at a …rst look the e¤ect appears to be quite strong (0.83 employment elasticity for Italy whereas it is smaller (0.57) for the US), employment increases less than the reduction in labour cost. That is, …rms are not translating completely lower labour cost into employment. Note that this policy experiment supports further the highly robust result that stronger employment e¤ects are associated to a higher initial taxation level. Moreover, in Italy the reduction in d is combined with an increase in private output. In contrast, in the US the e¤ect on private output is negative. Figure A5 summarises for both countries all the previous results by comparing the di¤erent e¤ects on wages and employment of changes in the

[34] This strong link in particular emerges if one compares the e¤ect on consumption and savings to the e¤ects on all the other macroeconomic variables.

[35] In a model where it is allowed for …rms' heterogeneity, we can interpret the positive e¤ect of increasing payroll tax progressivity in another way. It favours small …rms by reducing their hiring costs more than those sustained by big ones. Small …rms are those which might require a higher product demand for hiring new labour. Thereby, increasing payroll tax progressivity lowers the level of product demand necessary to small …rm to hire more work and on average it implies higher employment. A similar argument is sustained by Kolm (1999) who argues that imposing di¤erent payroll taxes on di¤erent sectors implies higher employment.

four tax parameters. Two things are worth noting. First, changes in the employment rate are much larger than those related to wages. Secondly, the higher the initial taxation level, the stronger the employment e¤ect.

Finally, we consider as a benchmark for the last policy experiment the actual tax variations reported in Table 5.[36;37] We obtain that according to our model in Italy the employment (unemployment) rate should be reduced (increased) by 7.9% whereas in US it should decrease (increase) by 2.32%. By looking at the same Table these rates of changes are quite close to the real ones. This seems to suggest that our model describes the relation between labour tax progressivity and employment.

6 Conclusions

This paper has presented a general equilibrium model on the relation among tax progressivity, wage setting and employment which distinguishes between the implications of changes in the degree of personal income and payroll tax progressivity. Furthermore, this current paper has pointed to the importance of the e¤ects of each of the four types of labour taxes which de…ne the two indices of tax progression. From a theoretical point of view three main conclusions can be derived. First, a general equilibrium framework introduces another e¤ect, the "interest rate e¤ect". This latter e¤ect can generate employment changes which are quite di¤erent from those related to real wages. Then, it would be interesting to analyse whether this result would hold in a small open economy where the real interest rate has to be taken as given. This is forwarded to future research. Secondly, the role played by the labour supply is crucial in determining the size and the sign of the e¤ect of changes in personal income taxation over wage setting and cancels out the hypothesis that given individuals' rational behaviour, personal income taxes and payroll taxes a¤ect wage determination in the same manner. Thirdly, employment e¤ects depend on the initial taxation level: the higher the tax level, the stronger the e¤ect. Some of these points address the question of whether unions are able to shift the tax burden onto …rms. According to our policy experiments, that were run through a calibration approach, the answer is no. Union markup variations can not help to account for employment changes.

[36] This kind of policy experiment allow us to assess the robustness of our result in presence of simultaneous changes in the four tax parameters.

[37] Note further that we …nd positive employment e¤ects (0.41% and 0.58% for Italy and the US) even when we allow for a 1% reduction in the average payroll tax rate holding constant the total tax revenues. The required increase in the average personal income tax rate results to be equal to 0.90% and 0.10% for Italy and the US respectively. As expected, given the non-linear structure of the two taxation systems, these values di¤er from 1%.

On the basis of this, the labour economists' common view seems to be right. Another extention of the model might consider if this result is robust to a industry level wage determination where the monopolistic union can not internalise all the macroeconomic e¤ects but where the Nash equilibrium is not longer the equilibrium solution. However, our policy experiments …nd also some evidence in favour of the Daveri and Tabellini's (2000) hypothesis according to which an economy's poor employment performance can be related to labour taxation. In particular, a 1% decrease in the average personal income and payroll tax rates has a relevant impact on employment (namely, 0.43% and 0.83%, respectively, for Italy; 0.60% and 0.57%, respectively, for the US). These e¤ects are strongly related to the interest rate mechanism and to the initial taxation level. Furthermore, in contrast to a linear taxation system, a nonlinear taxation system allows for the possibility that the e¤ects of counterbalancing tax changes do not cancel out and may in‡uence employment equilibrium. Taking as a benchmark for our policy experiment the actual …scal reform during the period 1978-97, variations in the employment rate implied by our model are quite close to those empirically observed.

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Appendix

Figure A1
Effects of Changes in Marginal Personal Income Tax Rate

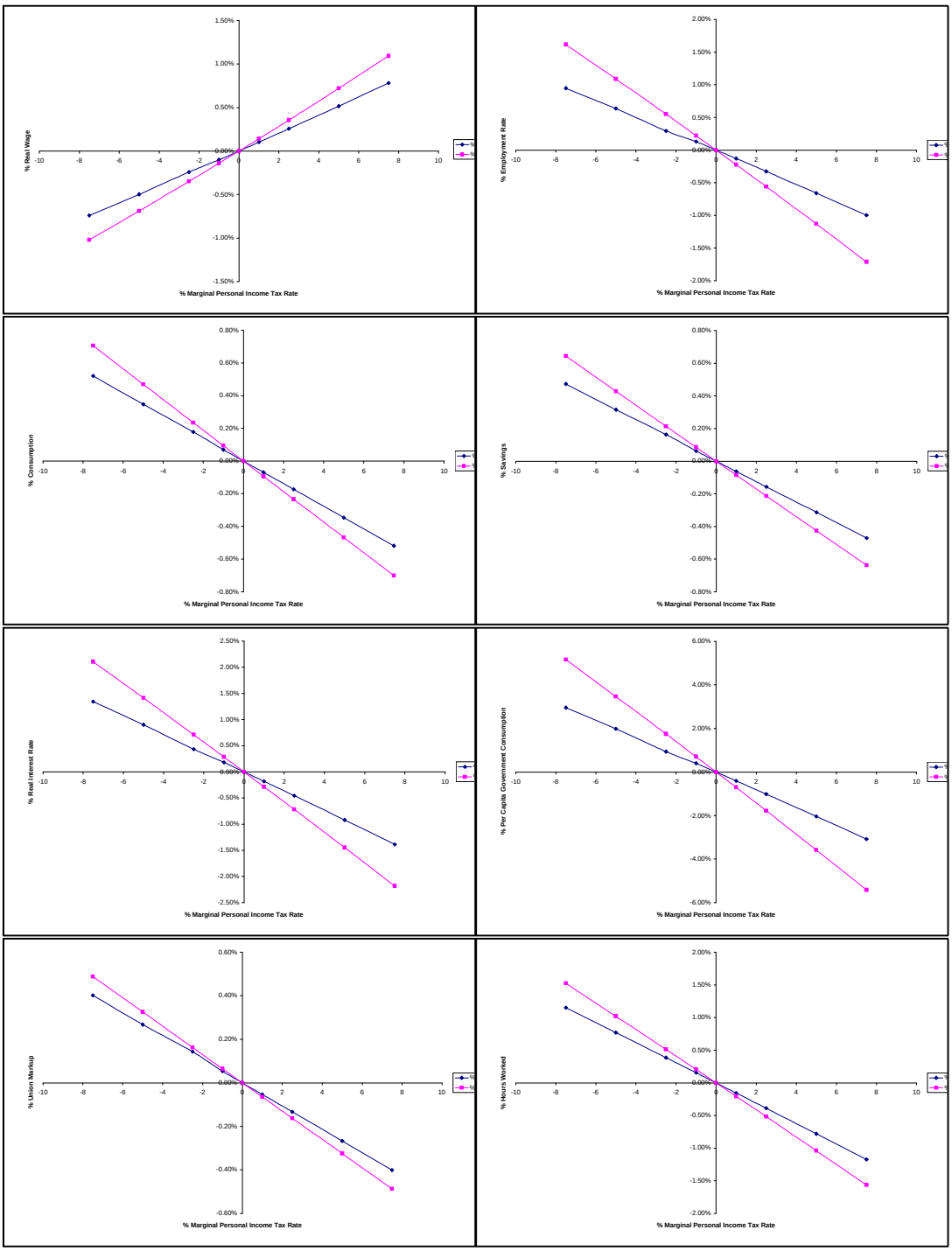

Table A1
E®ects of Changes in Marginal Personal Income Tax Rate

Italy									
%¿	%º¤	%w	%n	%M	%h	%c	%s	%r	%g
-1	0.39	-0.10	0.13	0.05	0.16	0.07	0.06	0.18	0.40
-2.5	0.97	-0.24	0.29	0.14	0.39	0.18	0.16	0.43	0.94
-5	1.94	-0.50	0.64	0.27	0.77	0.35	0.32	0.90	1.99
-7.5	2.91	-0.74	0.95	0.40	1.15	0.52	0.47	1.34	2.96
USA									
%¿	%º¤	%w	%n	%M	%h	%c	%s	%r	%g
-1	0.51	-0.14	0.22	0.07	0.21	0.09	0.09	0.29	0.70
-2.5	1.28	-0.35	0.55	0.16	0.51	0.23	0.21	0.71	1.75
-5	2.57	-0.69	1.09	0.33	1.02	0.47	0.43	1.41	3.47
-7.5	3.85	-1.02	1.62	0.49	1.53	0.71	0.64	2.11	5.16

Table A2
E f fects of Changes Average Personal Income Tax Rate

Italy										
%t	%º¤	%w	%n	%M	%h	%c	%s	%r	%g	%y
-1	-0.17	-0.13	0.43	-0.02	-0.07	0.04	0.03	0.23	0.59	0.03
-2.5	-0.43	-0.32	1.07	-0.06	-0.18	0.09	0.07	0.57	1.48	0.08
-5	-0.87	-0.63	2.14	-0.12	-0.35	0.18	0.14	1.14	2.97	0.17
-7.5	-1.29	-0.94	3.22	-0.17	-0.53	0.27	0.21	1.71	4.45	0.25
USA										
%t	%º¤	%w	%n	%M	%h	%c	%s	%r	%g	%y
-1	-0.24	-0.17	0.60	-0.03	-0.10	-0.52	-0.53	0.35	0.94	-0.53
-2.5	-0.60	-0.43	1.54	-0.07	-0.25	-0.45	-0.47	0.88	2.43	-0.46
-5	-1.20	-0.85	3.11	-0.14	-0.49	-0.32	-0.38	1.76	4.91	-0.34
-7.5	-1.78	-1.27	4.69	-0.21	-0.73	-0.20	-0.28	2.64	7.39	-0.22
1	0.24	0.17	-0.60	0.03	0.10	-0.62	-0.61	-0.35	-1.04	-0.62
2.5	0.61	0.43	-1.54	0.07	0.25	-0.69	-0.67	-0.88	-2.53	-0.69
5	1.22	0.85	-3.11	0.14	0.49	-0.82	-0.77	-1.75	-5.00	-0.80
7.5	1.85	1.27	-4.69	0.21	0.73	-0.94	-0.86	-2.62	-7.47	-0.92

Figure A2
E®ects of Changes Average Personal Income Tax Rate

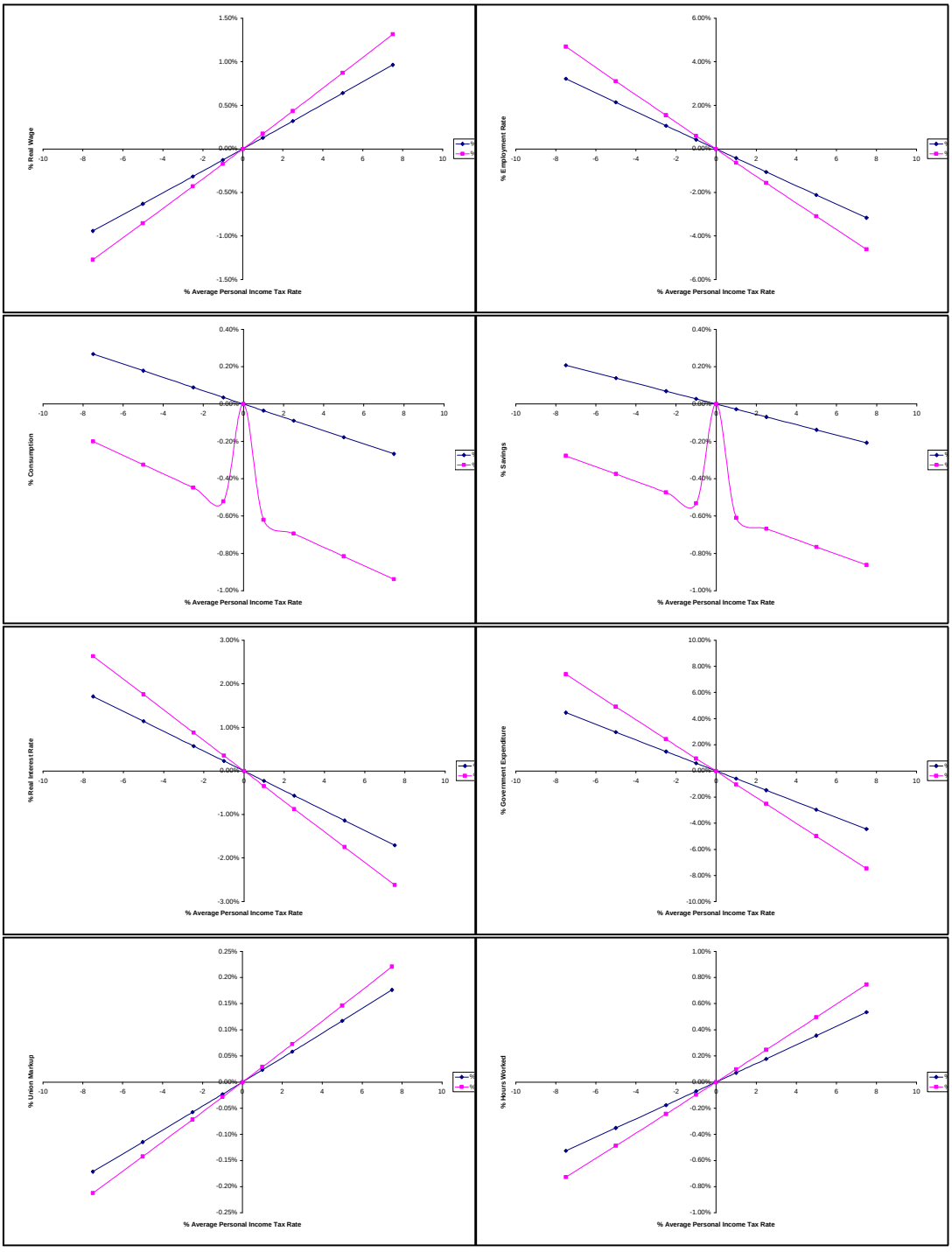

Figure A3
E®ects of Changes Marginal Payroll Tax Rate

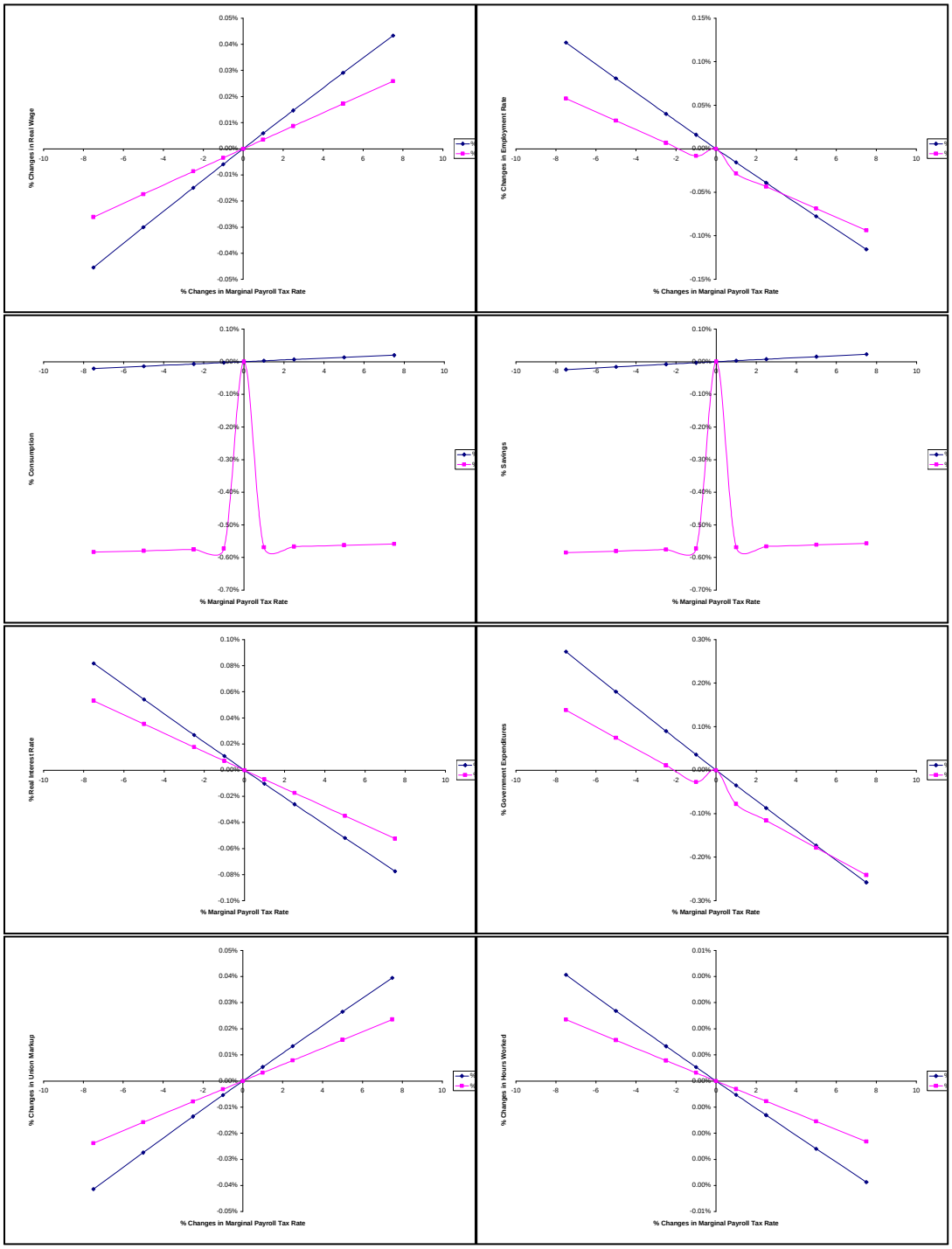

Table A3
Effects of Changes Marginal Payroll Tax Rate

Italy										
%±	%¤	%w	%n	%M	%h	%c	%s	%r	%g	%y
-1%	0.32	-0.01	0.02	-0.005	0.0005	-0.003	-0.003	0.01	0.04	-0.003
-2.5%	0.81	-0.02	0.04	-0.014	0.0013	-0.007	-0.008	0.03	0.09	-0.01
-5%	1.64	-0.03	0.08	-0.027	0.0027	-0.014	-0.016	0.05	0.18	-0.02
-7.5%	2.48	-0.05	0.12	-0.042	0.0041	-0.021	-0.024	0.08	0.27	-0.02
USA										
%±	%¤	%w	%n	%M	%h	%c	%s	%r	%g	%y
-1%	0.07	-0.003	-0.01	-0.003	0.0003	-0.573	-0.573	0.01	-0.03	-0.57
-2.5%	0.18	-0.009	0.01	-0.008	0.0008	-0.575	-0.576	0.02	0.01	-0.58
-5%	0.36	-0.017	0.03	-0.016	0.0016	-0.579	-0.58	0.04	0.07	-0.58
-7.5%	0.54	-0.026	0.06	-0.024	0.0024	-0.584	-0.585	0.05	0.14	-0.58
1	-0.07	0.003	-0.01	0.003	-0.0003	-0.569	-0.569	-0.01	-0.08	-0.57
2.5	-0.18	0.009	-0.01	0.008	-0.0008	-0.567	-0.566	-0.02	-0.12	-0.57
5	-0.36	0.017	-0.03	0.018	-0.0016	-0.562	-0.561	-0.04	-0.18	-0.56
7.5	-0.53	0.026	-0.06	0.024	-0.0024	-0.558	-0.557	-0.05	-0.24	-0.56

Table A4
Effects of Changes Average Payroll Tax Rate

Italy										
%d	%¤	%w	%n	%M	%h	%c	%s	%r	%g	%y
-1%	-0.31	0.01	0.83	0.01	-0.002	0.12	0.10	0.53	1.33	0.11
-2.5%	-0.76	0.02	2.11	0.02	-0.006	0.30	0.26	1.34	3.33	0.29
-5%	-1.53	0.04	4.27	0.03	-0.011	0.62	0.52	2.71	6.74	0.59
-7.5%	-2.29	0.07	6.50	0.05	-0.017	0.94	0.79	4.11	10.2	0.89
USA										
%d	%¤	%w	%n	%M	%h	%c	%s	%r	%g	%y
-1%	-0.20	0.01	0.57	0.01	-0.002	-0.49	-0.50	0.39	1.00	-0.49
-2.5%	-0.51	0.03	1.46	0.03	-0.005	-0.36	-0.39	0.98	2.58	-0.37
-5%	-1.02	0.06	2.96	0.05	-0.010	-0.15	-0.20	1.98	5.26	-0.16
-7.5%	-1.54	0.09	4.50	0.08	-0.015	0.07	-0.01	3.00	7.97	0.05
1	0.20	-0.01	-0.57	-0.01	0.002	-0.65	-0.64	-0.39	-1.10	-0.65
2.5	0.51	-0.03	-1.46	-0.03	0.005	-0.78	-0.75	-0.97	-2.65	-0.77
5	1.02	-0.06	-2.96	-0.05	0.010	-0.98	-0.92	-1.92	-5.22	-0.96
7.5	1.54	-0.09	-4.50	-0.08	0.015	-1.18	-1.09	-2.86	-7.74	-1.15

Figure A4
E®ects of Changes in Average Payroll Tax Rate

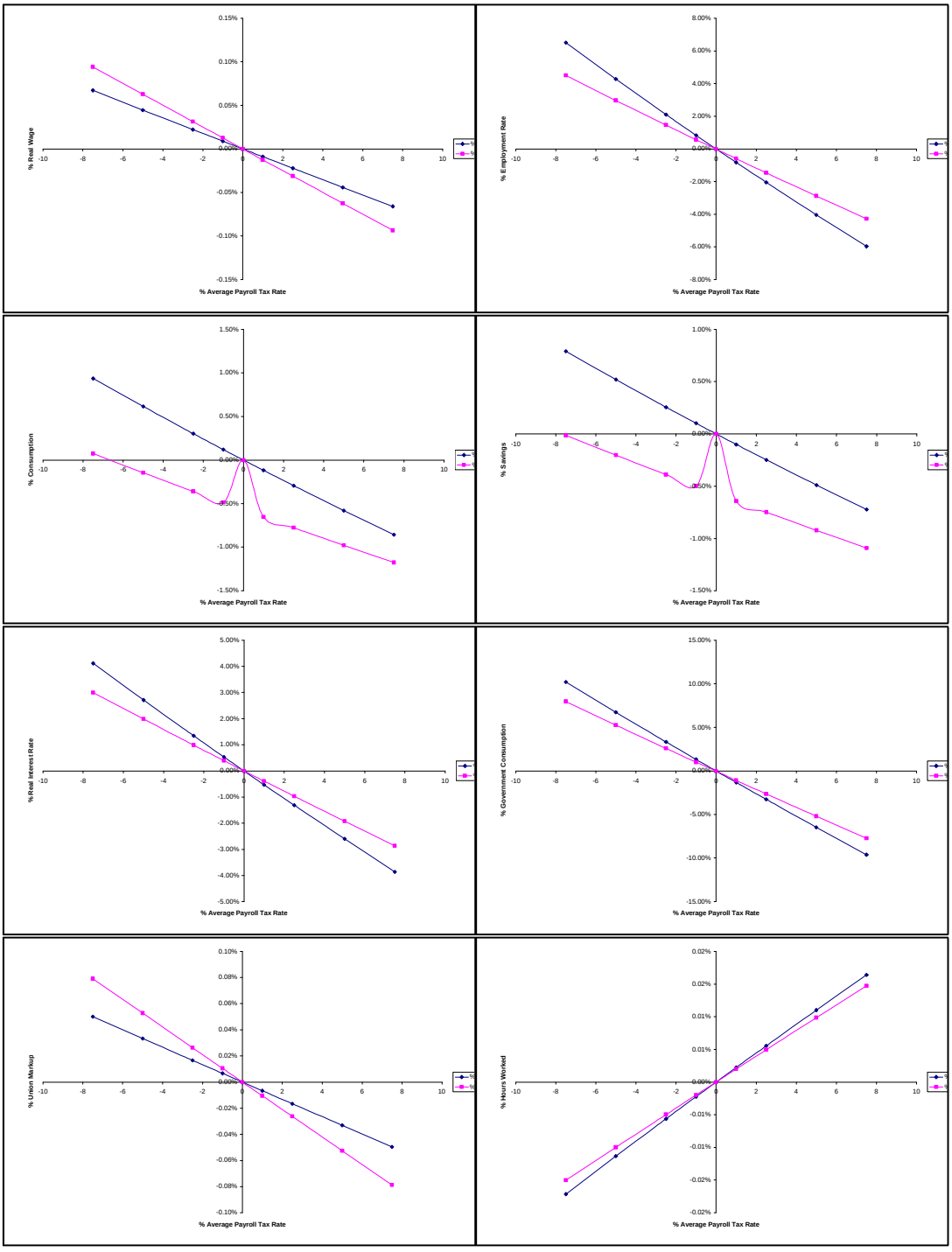

Figure 5
E®ects of Changes in the four tax parameters